

# Inventory of the vascular flora of the alkaline fen “Torbiera di Lipoi” (Veneto, northern Italy)

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## Abstract

On the basis of literature, and herbarium data and new field research, we provide a diachronic floristic inventory of a small alkaline fen meadow close to the southern border of the Dolomiti Bellunesi National Park (Veneto, N-Italy), whose toponymal is “Torbiera di Lipoi”. Overall, 319 infrageneric taxa were listed. Results indicate that, despite natural reforestation triggered by the abandonment of the traditional management of the fen, most of the fen-related vascular species still occur, including red-listed species, although their populations have probably decreased over time. Moreover, alien species are still a minor component of the flora, occurring in small scattered populations. However, there are signals of vulnerability, and probably the current vascular flora reflects a previous situation in which fen-related habitats were much larger than today. This urgently claims for active maintenance of the small open areas that still exist to counteract extinction debt dynamics.

## Keywords

Biodiversity, diachronic analysis, floristic data, phytogeography, Regional IUCN Red List, Wetlands

## Introduction

Due to land use change and cessation of traditional land use, alkaline fens of the *Caricion davallianae* Klika, 1934 are among the most endangered ecosystems in Europe (Seer and Schrautzer 2014; DG Environment 2017). These fens are particularly threatened in the southern Alps, where they are rare and small. In particular, fen

meadows that developed under low-intensity management are experiencing a decline in plant biodiversity and in rare and endangered plant species due to abandonment of traditional mowing (Billeter et al. 2007; Amici et al. 2015). Lack of mowing triggers natural reforestation, with consequent burial of areas with emerging water and rapid replacement of typical fen species with shrubs and trees. The urgency of stopping the ongoing trend requires targeted management actions and exhaustive floristic inventories in order to provide baseline data for supporting biodiversity conservation.

In this framework, we focused our research on a small alkaline fen meadow close to the southern border of the Dolomiti Bellunesi National Park (Veneto, N-Italy), whose toponymal is “Torbiera di Lipoi”, included in the Natura 2000 network. This site has been the subject of floristic studies and herbarium collections since the 1970s (Buffa and Lasen 2010). Floristic studies started in those years with student theses, such as that of L. Dalle Molle, published by Marcuzzi and Dalle Molle (1976). Later, some references to the “Torbiera di Lipoi” appeared in the floristic catalogue of the Alpi Feltrine (Lasen 1984), while in the same period the results of another thesis were published in a local journal (Ricci 1985). An exhaustive synthesis was published in 1993, which aggregated the floristic data available until that period, but scattered in different sources (Lasen 1993). Floristic research resumed only in 2023 thanks to researchers of the Department of Biological, Geological and Environmental Sciences (BIGEA) of the University of Bologna as part of the Project “Bando Habitat 2020 – Fondazione Cariverona – Progetto di rigenerazione e valorizzazione della Torbiera di Lipoi”.

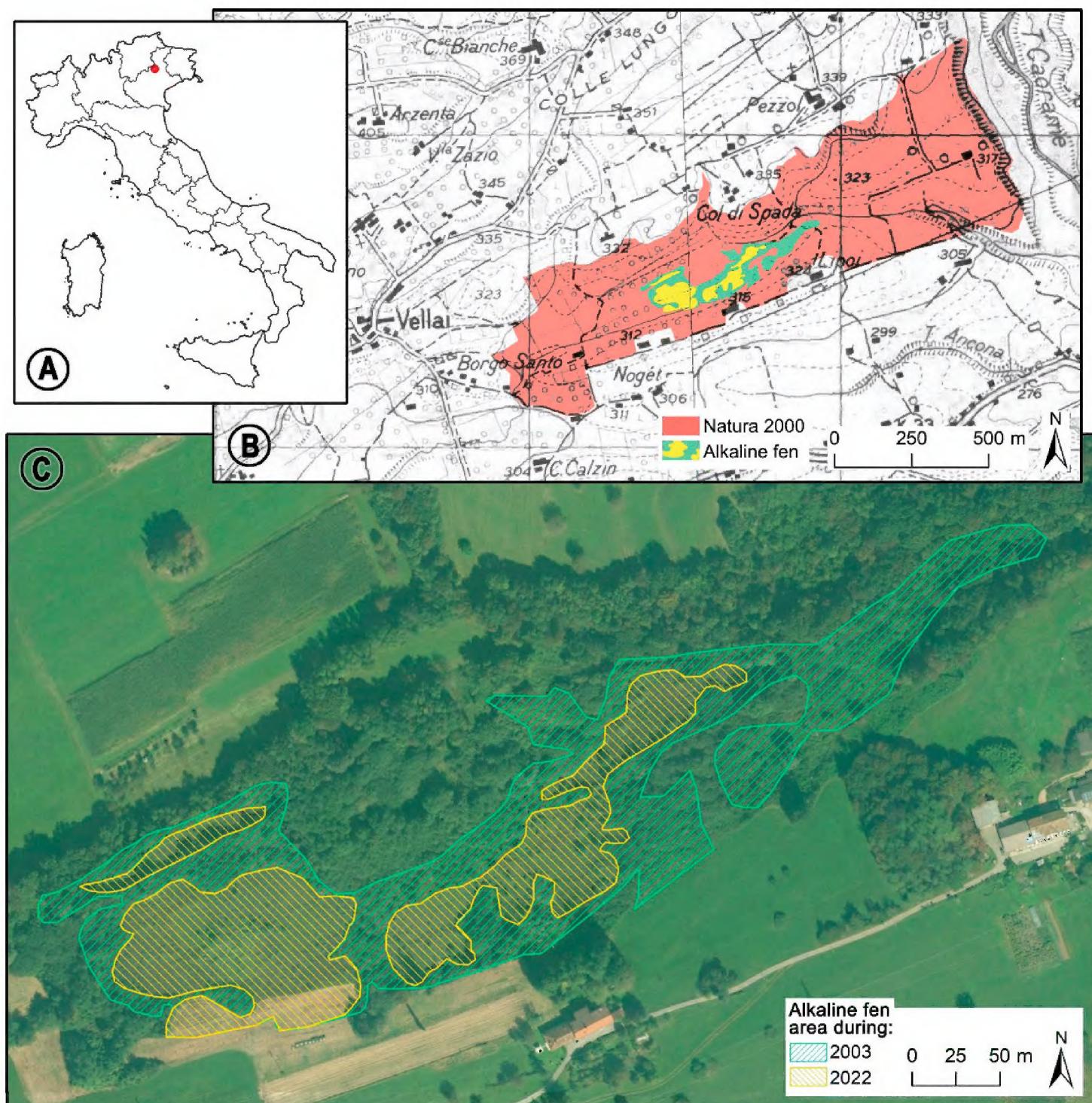
The specific aim of this work is to provide an updated catalogue of the vascular plants of this small fen and evaluate changes in floristic composition that could be related to abandonment of traditional management. We also aim at qualitatively interpreting ecosystem dynamics and provide some suggestions for future conservation of the vascular flora related to fen-habitats.

## Materials and methods

### Study area

The “Torbiera di Lipoi” (WGS84: 46.038611°N, 11.956667°E) is a rare case of alkaline fen of the *Caricion davallianae* alliance with elements of transition mires, located in a valley bottom of the pre-Alpine landscape of the Veneto region (mean elevation 300 m a.s.l.), precisely in Valbelluna, ENE of Feltre municipality (Belluno) and SE of the village of Vellai (Fig. 1A).

A peculiarity of the area surrounding the fen is the presence of a well-preserved traditional agroecosystem (Buffa and Lasen 2010), crossed by a rich hydrographic network with hedges and forest strips. For its natural and cultural values, the “Torbiera di Lipoi” is protected by the main urban planning instruments and represents the core area of a larger site of the Natura 2000 network (SAC “IT3230042 Torbiera di Lipoi”) that covers an area of 65 ha ([https://download.mase.gov.it/Natura2000/Trasmissione%20CE\\_dicembre2023/](https://download.mase.gov.it/Natura2000/Trasmissione%20CE_dicembre2023/)) (Fig. 1B).



**Figure 1.** **A** the *Torbiera di Lipo* site in Italy **B** the alkaline fen in the context of the Natura 2000 area **C** the extension of the fen in 2003 (green hatching) and in 2022 (yellow hatching).

The soil is made up of fluvial and alluvial overlying deposits of calcareous moraines, originating from the Piave river glacier (Marcuzzi and Dalle Molle 1976; ARPAV 2005). The climate is temperate – continental (ARPAV 2000), with annual average temperature of about 12 °C and abundant precipitation (mean annual precipitation 1,200–1,500 mm) with peaks in autumn and spring (Barbi et al. 2013).

The “Torbiera di Lipo” was mowed for the production of straw and hay until the end of the last century. In the last decades, the abandonment of traditional mowing has strongly reduced the surface of the fen, modifying its physiognomy. Between 2003 and 2022, approximately 45% of its surface went lost due to natural encroachment (Fig. 1C). Currently, the fen is a mosaic of natural and semi-natural habitats, including those of alkaline fens (habitats Natura 2000 code 7210\* and 7230), transition mires (habitat 7140), *Molinia* meadows on calcareous substrates (habitat 6410),

hygrophilous tall herb fringe communities (habitat 6430), hygrophilous *Alnus glutinosa* woods (habitat 91E0\*), Central European oak-hornbeam forests (habitat 9160), and stable hay meadows (habitat 6510). Willow groves dominated by *Salix cinerea* L. and *Phragmito-Magnocaricetea* Klika in Klika and Novák 1941 vegetation represent two additional habitats that are not included in the Natura 2000 framework.

## Floristic inventory

Data on vascular plants was retrieved from all available sources: four literature sources (Marcuzzi and Dalle Molle 1976; Lasen 1984, 1993; Ricci 1985), one local herbarium (i.e. “Herbarium C. Lasen” preserved at the Museo Naturalistico Dolomiti Bellunesi, Belluno), and recent fieldwork carried out between 2023 and 2024 in the framework of the Project “Bando Habitat 2020 – Fondazione Cariverona – Progetto di rigenerazione e valorizzazione della Torbiera di Lipoi”.

The temporal distribution of the data covers a time span of 50 years, from 1974 to 2024, with a first catalogue in 1993 (Lasen 1993), when the alkaline fen was still traditionally managed. Even if the exact position of the historical records is not known, the study site is morphologically well defined and, therefore, a diachronic comparison between the pre-abandonment period and the current situation, after about 20 years of abandonment, is reasonable and useful for future conservation, monitoring and management. The floristic scenario related to the pre-abandonment period was based on bibliographic and herbarium data, while that referred to the current situation results from a new exhaustive floristic survey carried out during spring-summer 2023 and 2024. To evaluate shifts in floristic composition between the pre-abandonment period and the current situation, life forms, chorology, and conservation value of the species were compared between the two periods. Taxonomic, nomenclatural and distributional data were retrieved from the Portal to the Flora of Italy (<https://dryades.units.it/floritaly/index.php>; Martellos et al. 2020), updated according to the most recent checklists of the native (Bartolucci et al. 2024) and alien plants of Italy (Galasso et al. 2024). The local distribution and IUCN category refer to the Flora of Veneto (Argenti et al. 2019) and to the Red List of Veneto (Buffa et al. 2016) respectively, while life forms and chorotypes were retrieved from Pignatti et al. (2017a, 2017b, 2018).

## Results

The catalogue of the vascular flora of the “Torbiera di Lipoi” includes 319 infrageneric taxa (Suppl. material 1). Seventy-seven taxa were newly found only during the recent floristic survey, while 165 taxa have been confirmed from historical surveys. Seventy-eight taxa were not confirmed. Among these, the historical occurrence of *Carex acuta* L., *C. riparia* Curtis, *Galium palustre* L. subsp. *elongatum* (C.Presl) Arcang., *G. verum* L. subsp. *wirtgeni* (F.W.Schultz) Oborny, and *Ranunculus tuberosus* Lapeyr. is considered doubtful and probably due to misidentification.

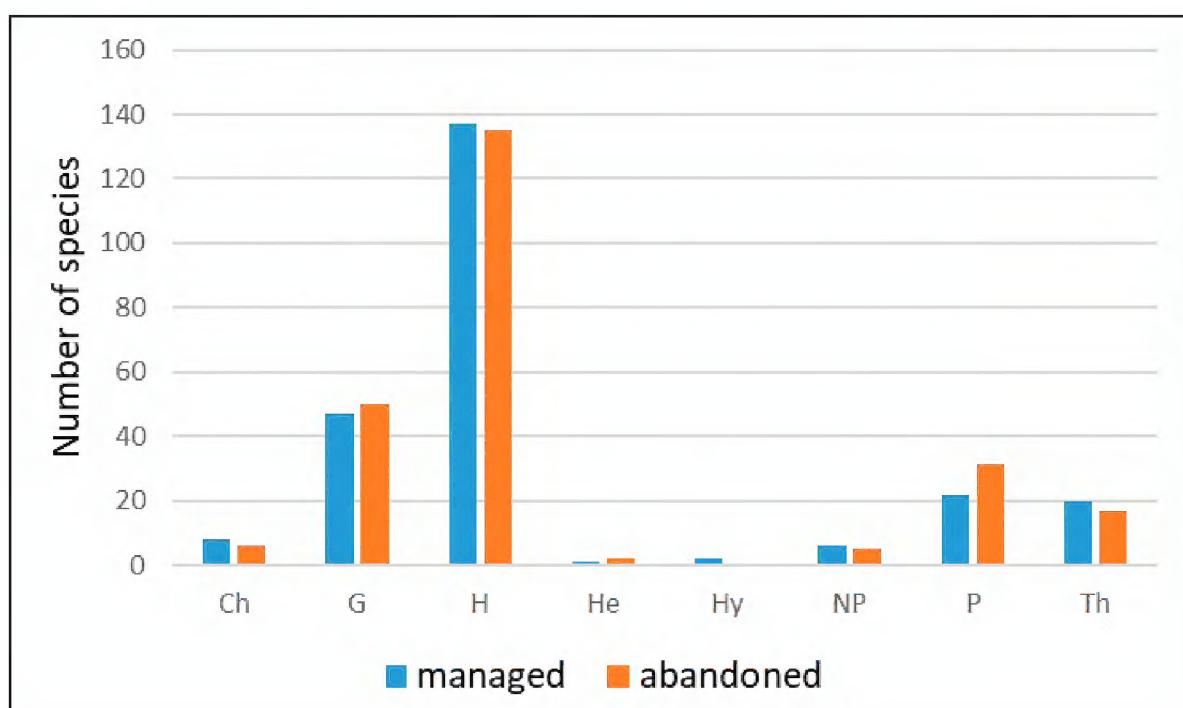
The infrageneric taxa belong to 67 families, seven of which account for about 55% of the total vascular flora (Poaceae 37 taxa, Cyperaceae 32, Asteraceae 20, Lamiaceae 16, Ranunculaceae 16, Rosaceae 16, Fabaceae 14). Compared to the pre-abandonment period, Campanulaceae, Lentibulariaceae, Linaceae, Polygalaceae, and Potamogetonaceae were not found during the recent survey, while new families were found, *viz.* Caprifoliaceae, Dioscoreaceae, and Onagraceae.

The analysis of life-forms highlights that hemicryptophytes, geophytes, phanerophytes, and therophytes are the most represented, followed by nanophanerophytes, and chamaephytes. Proportions of life forms are relatively constant over time (Fig. 2), even if hydrophytes were not found during the recent survey and phanerophytes tended to increase.

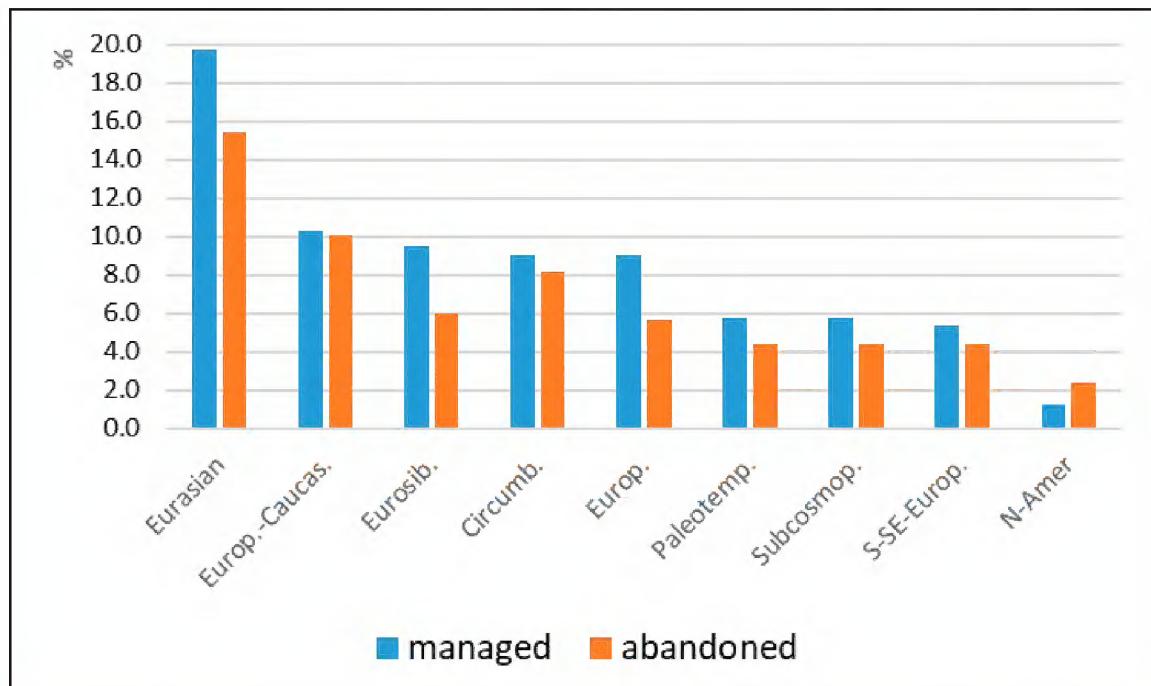
The chorological spectrum is dominated by Eurasian, European-Caucasic, Eurosiberian, European and Circumboreal species, while Paleotemperate, Subcosmopolite, and south-southeastern European species are less represented. Compared to the pre-abandonment period, the Eurasian, Eurosiberian, and European species clearly decrease (Fig. 3).

North American species are the main alien taxa and their proportion increased over time. Overall, alien species represent 4.4% of the total flora. Ten are invasive (e.g. *Sympyotrichum lanceolatum* (Willd.) G.L.Nesom, and *Solidago gigantea* Aiton), one is naturalized, one casual and two cryptogenetic.

*Plantago altissima* L. is included in the regional Red List (Buffa et al. 2016) as critically endangered. Seven species are considered vulnerable: *Festuca trichophylla* (Ducros ex Gaudin) K.Richt., *Gentiana pneumonanthe* L., *Carex lasiocarpa* Ehrh., *Carex randalpina* B.Walln., *Dactylorhiza incarnata* (L.) Soó, *Equisetum fluviatile* L., *Taraxacum* sect. *Palustria* (H.Lindb.) Dahlst., while *Epipactis palustris* (L.) Crantz, *Menyanthes trifoliata* L., and *Cladium mariscus* (L.) Pohl are near threatened. Two



**Figure 2.** Comparison of the life forms composition between the pre-abandonment period and the current situation. Life forms abbreviations: Chamaephytes (Ch); Geophytes (G); Hemicryptophytes (H); Helophytes (He); Hydrophytes (Hy); Nanophanerophytes (NP); Phanerophytes (P); Therophytes (Th).



**Figure 3.** Comparison of the chorotype composition between the pre-abandonment period and the current situation.

**Table 1.** Temporal distribution of observations. Species included in the threat categories of the Veneto Red List for which it is necessary to implement specific conservation actions, VU = Vulnerable; EN = Endangered; CR = Critically Endangered.

	Year of observation												
	1976	1981	1982	1983	1984	1985	1993	1996	2012	2013	2015	2022	2023
CR													
<i>Plantago altissima</i> L.					✓	✓		✓				✓	✓
EN													
<i>Utricularia minor</i> L.	✓	✓			✓		✓	✓					
RE													
<i>Potamogeton gramineus</i> L.			✓										
VU													
<i>Carex lasiocarpa</i> Ehrh.									✓	✓			✓
<i>Carex randalpina</i> B. Walln.									✓	✓	✓	✓	
<i>Dactylorhiza incarnata</i> (L.) Soó							✓	✓					✓
<i>Equisetum fluviatile</i> L.				✓		✓	✓	✓					✓
<i>Festuca trichophylla</i> (Ducros ex Gaudin) K.Richt.					✓		✓						✓
<i>Gentiana pneumonanthe</i> L.					✓			✓				✓	
<i>Taraxacum</i> sect. <i>Palustria</i> (H.Lindb.) Dahlst.								✓					✓

red-listed species recorded in the past were not found, and could be extinct at the local level, i.e. *Rosa gallica* L., *Utricularia minor* L.; *Potamogeton gramineus* L. is considered extinct at the regional level (Buffa et al 2016; Bartolucci et al. 2024) (Table 1).

## Discussion

Natural reforestation, triggered by the abandonment of traditional management of the fen, strongly modified the vegetation of the “Torbiera di Lipo”, mainly by reducing the surface of the most typical fen-related Natura 2000 habitats and likely causing the local extinction of strictly aquatic taxa, such as *Potamogeton gramineus* and

*Utricularia minor*. However, our results indicate that most of the fen-related vascular species still occur, including red-listed ones, although their populations have probably decreased over time. Interestingly, this does not appear to be the case for *Cladium mariscus* and *Carex lasiocarpa* that are clearly expanding in the fen (personal observation of the authors).

The prevalence of hemicryptophytes in the vascular flora of our study site indicates adaptation to grazing or mowing, typical of open herbaceous environments (Midolo et al. 2024). However, according to our diachronic comparison, the trend is towards a decrease in the number of species with biological forms typical of open environments and an increase in the number of species linked to reforestation, as in the case of geophytes and phanerophytes. This trend is corroborated by historical bibliography. For example, in Ricci (1985), *Salix cinerea*, *Alnus glutinosa* (L.) Gaertn., and *Quercus robur* L. subsp. *robur* were mentioned as occurring in scattered populations, while currently they are widespread across much of the fen surface. Similarly, other species of trees and shrubs and also herbaceous plants have colonized the site in recent decades, as in the case of *Frangula alnus* Mill. subsp. *alnus* and *Phragmites australis* (Cav.) Trin. ex Steud.

Besides these dynamics, the biogeographic framework of the vascular plant biota is relatively stable, as indicated by the prevalence across time slices of the chorotypes that are typical of fen habitats, as in the case of Eurasian, Eurosibirian, European-Caucasian, and Circumboreal chorotypes that reflect the continental and microthermal character of the cold-temperate zones. The SSE-European chorotype is indicative of the south-eastern Alpine character of the “Torbiera di Lipo”. However, the steep reduction of fen-habitats during the last 20 years suggests that in the near future the biogeographic structure of this site could also be modified. This view is also corroborated by the increase in the number of alien, mainly north-American, species. Actually, only *Veronica persica* Poir., *Robinia pseudoacacia* L., *Erigeron annuus* (L.) Desf. subsp. *annuus*, and *Oxalis stricta* L., were already recorded since the 1990s (Lasen 1993), before abandonment of traditional management. Fortunately, with the exception of *Sympyotrichum lanceolatum* that forms a relatively large but defined population in the eastern sector of the fen, alien species still occur in small scattered populations. This indicates, on the one hand, that the site still holds a low risk of invasion but, on the other, that its fragility is connected to the fact that any disturbance could immediately trigger an invasion process since the sources of propagules are already on site (Corcos et al. 2020).

## Conclusions and suggestions for conservation

Despite rapid reforestation dynamics, our study indicates that the vascular flora of this small alkaline fen still reflects a previous situation in which fen-related habitats were much larger than today. In other words, the extinction debt related to the reduction of these habitats does not yet seem to have been completely paid and this still provides some opportunities for the conservation of several fen-related species in the future (Kuussaari et al. 2009). Since it is unlikely that the traditional management conditions of the past will be restored, or that newly formed forest habitats (that are also interesting for many animal species) will be eliminated, the possibility for conservation

is limited to the active maintenance of the small open areas that still exist. However, management activities must be conducted on a small scale, with extremely limited operations (e.g., manual mowing and fast removal of material outside the fen) and in the appropriate season (e.g., winter) to avoid the risk of triggering the spread of alien species, which could also be enhanced by the increasingly favorable climatic conditions linked to global change. Furthermore, management activities should be combined with a suitable monitoring program to promptly evaluate their effects and make any changes if unexpected dynamics arise.

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## Supplementary material I

### Floristic list and records

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Data type: docx

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